ILLINOIS SUPERCONDUCTOR CORPORATION (ISC)

Using High-Temperature Superconductivity to Improve Cellular Phone Transmission

The number of cellular phones used in the United States has mushroomed in the last decade. Estimates provided by the Cellular Telecommunications Industry Association are that the number of wireless telephone subscribers was over 50 million as of August 1997. Additional estimates are that by 2001 the cellular subscriber base is expected to grow to more than 75 million subscribers, with an additional 15.1 million subscribers using personal communications services (PCS) by the same year.

COMPOSITE PERFORMANCE SCORE
(based on a four star rating)
* * *

Extending and Improving Cellular Phone Service

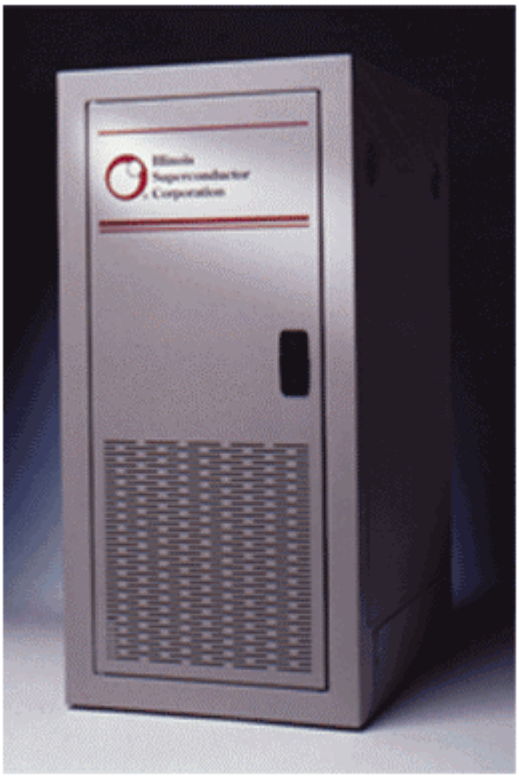
To provide cellular phone or PCS service, a communications company using a land-based approach must place base stations — towers and reception/transmission equipment — at regular intervals throughout its service area. In deciding where to locate these base stations, the company considers the strength and clarity of its communications signals and how customer service will be affected when a signal shifts from one station to the next while the customer is traveling.

All these factors depend on how well the station's equipment handles the communications signals. And that depends on how well each component of the equipment works as it attempts to distinguish the user's cellular phone signal from the surrounding electronic noise.

A High-Temperature Superconductivity Solution

This ATP project with Illinois Superconductor Corporation (ISC), a small company founded in 1990, developed technology based on high-temperature superconductivity (a phenomenon discovered in 1986) to significantly improve the quality of signal transmission.

Superconducting components offer great benefits to cellular phone communications, including improvements in range, receiver sensitivity, and frequency stability. These improvements, in turn, will extend the range of base stations, reducing the number needed to cover a given area and decreasing the costs of cellular phone service. Cellular phone users will receive clearer signals and suffer fewer dropped calls as their signals move from one base station site to the next.



A compact one-box enclosure for RangeMaster and SpectrumMaster

PROJECT HIGHLIGHTS

Project:
To develop high-temperature, superconducting thick-film materials for equipment used in the reception/transmission stations of cellular phone and other communications systems.

Duration: 3/1/1993 — 2/29/1996
ATP Number: 92-01-0017

Funding (in thousands):

ATP	$1,980	56%
Company	1,555	44%
Total	$3,535	

Accomplishments:
ISC developed and demonstrated a robust fabrication process to produce radio-frequency (RF) components using thick-film, high-temperature superconductivity (HTS) technology. It developed a model that predicts the impact of high-performance filters on future digital wireless systems. The company also:

- received five patents for technologies related to the ATP project:

"Superconducting YBa.sub.2 Cu.sub.3 O.sub.7-x Produced at Low Temperatures"
(No. 5,527,765: filed 8/23/1994, granted 6/18/1996),
"Electromagnetic Resonant Filter Comprising Cylindrically Curved Split Ring Resonators"
(No. 5,616,540: filed 12/2/1994, granted 4/1/1997),
"Electromagnetic Resonator Comprised of Annular Resonant Bodies Disposed Between Confinement Plates"
(No. 5,629,266: filed 12/2/1994, granted 5/13/1997),
"Resonator Mounting Mechanism"
(No. 5,604,472: filed 12/1/1995, granted 2/18/1997), and
"Superconducting Re-entrant Resonator"
(No. 5,682,128: filed 4/23/1996, granted 10/28/1997);

- applied for one additional patent for technology related to the ATP project;

- raised $17.4 million through an initial public stock offering in October 1993;

- completed construction of a plant to manufacture RF filters and related products;

- began selling SpectrumMaster® in 1996 and RangeMasterTM in 1997, both of which are based on the ATP-funded technology;

- received the Microwave & RF magazine 1996 Top Product Award for "cellular phone site filters, superconducting ceramics," which were selected from a field of 5,000 new products; and

- received (with subcontractor Lucent Technologies) a Corporate Technical Achievement Award for 1997 from the American Ceramic Society.

Citations by Others of Project's Patents:
See Figure 1.

Commercialization Status:
Commercialization is in progress and products are being sold. The benefits of lower costs and higher-quality service are accruing to companies that use ISC's new technology and to their customers.

Outlook:
The outlook for this new technology is excellent. Its use is expected to spread throughout the economy, lowering the costs and improving the quality of cellular phone and personal communication services.

Number of employees: 8 at project start, 75 at the end of 1997

Composite Performance Score: * * *

Company:
Illinois Superconductor Corporation (ISC)
451 Kingston Court
Mt. Prospect, IL 60056

Contact: Ben Golant
Phone: (847) 391-9416

. . . received the Microwave & RF magazine 1996 Top Product Award for "cellular phone site filters, superconducting ceramics" . . .

Despite the promise of superconducting components, little prior work had gone into developing HTS components for the radio-frequency (RF) spectrum, which is used by cellular phone systems. Difficulties in economically making the relatively large, geometrically complex structures needed for these frequencies were partly to blame. ISC solved this problem by developing the ability to use thick-film HTS coatings on inexpensive substrates.

Focus on Preselector Receive Filters

The goal of the ATP project was to develop and demonstrate consistently performing RF superconducting components in a prototype base station. During the ATP project, however, ISC narrowed its focus (with ATP approval) to preselector receive filters, which remove all extraneous RF signals and leave only those within the cellular spectrum allotted to that particular operator. Investigation of the cellular market indicated that the superconducting preselector receive filter was of greatest interest to customers in terms of improving system performance.

Given the limited resources available to ISC, the company decided to focus on this component as an initial goal and to integrate others later. The new HTS technology is useful for other RF equipment and has potential applications in antennas, magnetic resonance imaging machines and other components of communications systems. ISC successfully incorporated the ATP-funded technology in a preselector receive filter and, in late 1996, started selling it under the name of SpectrumMaster® to companies operating cellular phone systems. A year

later, it launched RangeMaster®, which contains the SpectrumMaster® preselector receive filter and a cryogenically cooled low-noise amplifier. By September 1997, ISC had installed SpectrumMaster® or RangeMaster® in 22 base stations in 12 cities and had successfully completed 16 field trials in 10 cities. Sales at that time amounted to $1 million. The company has also modified and installed SpectrumMaster® for use in the base stations of personal communications systems.

Improved Communications Service

The future looks bright for ISC as it uses the ATP-funded technology to help communications companies serve their customers with greater-quality services at lower costs. Cellular phone service companies can reduce the number of new base station sites they install. They can also expand by up to 25 percent the range of existing sites by replacing an older filter at the station with a new one based on the ATP-funded technology. A 25 percent range increase corresponds to a 56 percent increase in the area covered and translates into a 40 percent decrease in the number of sites required to cover the

By September 1997, ISC had installed SpectrumMaster™ or RangeMaster™ in 22 base stations in 12 cities and had successfully completed 16 field trials in 10 cities.

area. The cost of the improved filter is around $25,000 to $60,000, depending on site configuration, whereas the cost of a new site is about $1 million to $2 million. The future also looks bright for customers of these communications companies, as costs drop and service quality improves.

Even greater benefits should accrue to cellular and personal communications customers with the conversion from analog to digital communications. Digital stations must transmit much more data per call, so any quality improvements or cost reductions will

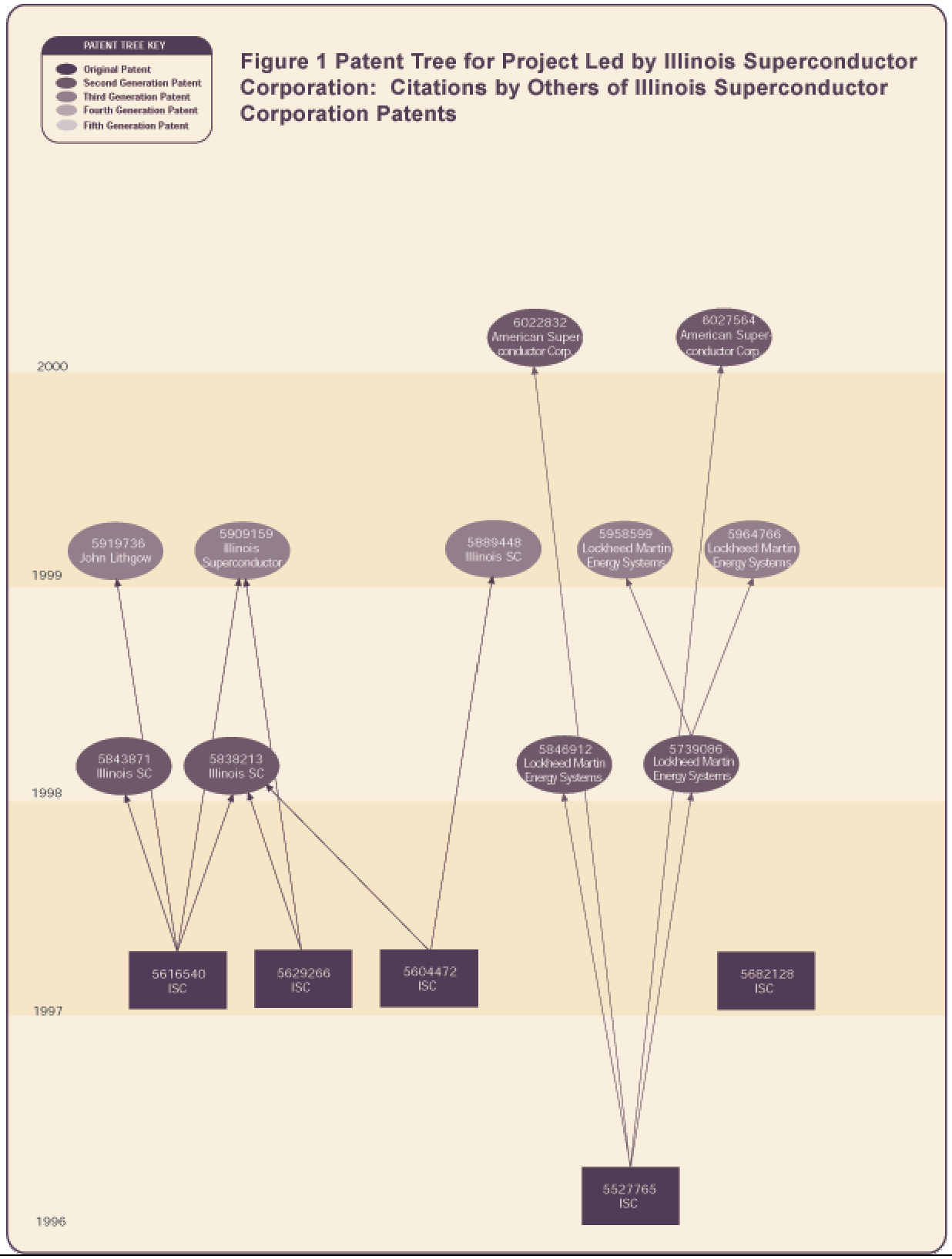
A ceramic torroid form, coated with thick film HTS material, designed to resonate at a specific frequency.

apply to a larger volume of signal traffic. As more transmission sites install digital systems, cellular phone users will get clearer signals and fewer dropped calls. Other sectors, such as mobile communications, will experience lower costs and improved quality as the technology is extended to them. Proliferation of the new technology will provide an additional benefit in terms of aesthetics by reducing the number of signal towers installed for communications systems.

A 25 percent range increase corresponds to a 56 percent increase in the area covered and translates into a 40 percent decrease in the number of sites required to cover the area.

ATP Award Accelerates Development

Funding from the ATP enabled ISC to form alliances with research partners and contractors and to achieve its research and development results about 18 months earlier than it would otherwise have been able to do. Company officials say the ATP award also enabled ISC to survive as a company and gave its technology and commercialization plan significant credibility with investors. The increased credibility, in turn, directly helped the company raise private capital, especially during its initial public stock offering in 1993.



This status report was written during 1997-1998 and published in March 1999.